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Abstract

Background: Conjunctival closure is a vital but inconsistently performed phase of strabismus surgery, affecting postoperative healing, inflammation, and patient comfort. Over the last few years, sutureless and minimally invasive techniques like minimally invasive strabismus surgery (MISS), Half-MISS, fibrin-glue sealing, and forniceal incisions have been suggested to enhance surgical recovery. This systematic review and consultant survey sought to compare current evidence and real-world practice patterns concerning conjunctival closure methods in strabismus surgery.

Methods: A systematic review was performed according to the PRISMA 2020 guidelines. PubMed, Embase, Web of Science, Cochrane Library, and ClinicalTrials.gov were searched and found studies published between 2010 and 2025 comparing sutureless with conventional sutured conjunctival closure. Risk of bias was evaluated using the RoB-2 and ROBINS-I tools. Due to methodological heterogeneity, a narrative and thematic synthesis approach was utilized.

Additionally, a consultant survey of members of the British and Irish Paediatric Ophthalmology and Strabismus Association (BIPOSA) was conducted to assess current clinical practices and factors influencing closure technique selection.

Results: A total of 13 studies (8 Randomised controlled trials and 5 comparative observational studies) encompassing approximately 740 eyes were included. Sutureless methods especially MISS, Half-MISS, and fibrin-glue closure exhibited lower post-op inflammation, greater comfort, quicker healing, and less operative time than standard 8-0 Vicryl suturing, with ocular alignment and complication rates as good as, or better than, conventional suturing. Risk of bias was low to moderate in most domains, with more than 75% assessed as low risk.

The consultant questionnaire (n = 53; ~60% response rate) elicited that 92% of UK consultants still employed sutured closure, explaining mainly by wound security (85%), familiarity with training (65%), and cost savings (55%) as predominant factors. Routine use of sutureless methods was reported by only 4%. Irritation associated with the knot was uncommon and seldom necessitated follow-up, but slight redness was still prevalent.

Conclusions: Evidence across the last decade overwhelmingly supports the safety and functional equivalence of sutureless conjunctival closure methods with benefits in comfort, healing, and efficiency. Consultant practice today, however, is still conservative, indicating a translational gap between evidence and clinical practice. This gap must be bridged by focused education, cost-utility analysis, and incorporation of minimally invasive closure methods into formalized surgical training curricula so that evidence-based innovation can be translated into real-world practice.

Keywords: Strabismus surgery; Conjunctival closure; Fibrin glue; Forniceal incision; Sutureless technique;

1.0 Introduction

Strabismus surgery is one of the most common ophthalmic surgeries, most commonly in children, and normally involves conjunctival incision for exposing the extraocular muscles (RCOphth, 2017). The technique of conjunctival closure can significantly impact short-term healing and long-term ocular surface consequences. Historically, closure has been achieved by suturing, which allows firm apposition of the wound but can increase operative time and postoperative pain and inflammation (Lee & Kang (2011). These disadvantages have spurred increased interest in alternative sutureless methods to enhance efficiency and patient comfort.

During the past decades, sutureless techniques like fibrin glue, diathermy, and laser-assisted sealing have been investigated in various ophthalmic subspecialties. Data from pterygium and corneal surgery indicate that sutureless closure will decrease operative time, decrease recurrence rates, and enhance postoperative comfort (de Wit et al., 2010; Pan et al., 2011; Koranyi et al., 2005). Early comparative works in strabismus surgery have also shown possible advantages (Dadeya and Kamlesh 2001), reports also observed that fibrin glue had shorter operating times and fewer postoperative symptoms than vicryl sutures, and Lee and Kang (2011) documented lower rates of discomfort and inflammation in fibrin glue-treated patients. However, such studies were limited by single-center designs, heterogeneous outcome measures, and small sample sizes and created doubt regarding long-term safety and generalizability.

To assess current practice, a survey of British and Irish Paediatric Ophthalmology and Strabismus Association (BIPOSA) members was undertaken nationally. The poll discovered that 92 % of consultants still employed sutured conjunctival closure, with just 4 % utilizing sutureless

methods like diathermy or spontaneous closure. The most commonly reported postoperative complications were ocular redness (72 %) and discomfort (15 %), highlighting that though suturing is safe for wound stability, it can be at the expense of postoperative comfort. Knot-related irritation seldom required additional follow-up visits, indicating that although clinical burden is limited, patient-reported irritation persists.

This disparity between clinical practice and new evidence reveals a significant knowledge gap. In spite of theoretical and empirical benefits to sutureless closure, there has been no systematic synthesis contrasting its efficacy, safety, and cost-effectiveness with those of traditional suturing in strabismus surgery. No previous study has also synthesized professional practice information with the literature evidence to learn about real-world congruence with research results.

Thus, this research conducts a systematic review and survey of consultants using a mixed-methods approach to assess and put into context conjunctival closure methods in strabismus surgery. The review seeks to (a) provide meta-analysis of published data contrasting sutureless and sutured approaches to postoperative outcome, operating time, and patient comfort; and (b) combine national survey findings to learn about factors hindering adoption and provide evidence versus practice gaps in day-to-day surgical operations. By bridging scientific investigation and professional expertise, this research aims to inform clinical practice guidelines, maximize patient outcomes, and direct future multicenter trials.

2.0 Methodology

2.1 Study Design

The study used a mixed-methods design, combining a systematic review of the peer-reviewed literature with data from a national consultant survey. The systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines (Page et al., 2021). The survey part adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines for cross-sectional studies.

2.1.1 Eligibility Criteria

The studies were eligible to be included if they: Compares suture-based versus sutureless conjunctival closure methods in strabismus surgery. Reported at least one of the following results: postoperative inflammation,

discomfort, quality of healing, operative time, cost, or patient satisfaction. Were RCTs, quasi-experimental studies, or comparative observational studies. Excluded non-comparative case series, reviews, editorials, and animal studies. Only English language studies were included.

2.1.2. Search Strategy

A detailed search was carried out in PubMed/MEDLINE, Embase, Cochrane Library, and Web of Science from 2010 up to September 2025. The combination of controlled vocabulary (MeSH) and free text terms were used in the search, such as: ("conjunctival closure" OR "conjunctival healing" OR "sutureless") AND ("strabismus surgery" OR "extraocular muscle surgery") AND ("fibrin glue" OR "tissue adhesive" OR "diathermy" OR "laser").

2.1.3 Study Selection

Two reviewers independently screened all titles, abstracts, and full texts with Excel sheet. Disagreements were resolved by discussion or by arbitration from a third reviewer. The process of selection was tracked via a PRISMA flow diagram.

2.1.4 Data Extraction

A standardized data extraction form was created to gather: Author, year, country, and study design, participant characteristics (age, sex, sample size), surgical technique and closure method.

Comparator information included, primary and secondary outcomes (postoperative inflammation, quality of healing, discomfort, operative time, recurrence, and cost), follow-up period and adverse events. Extracted data were entered in a structured spreadsheet and cross-checked by two reviewers for completeness.

2.1.5 Quality Assessment

The Cochrane Risk of Bias 2.0 tool was applied for Randomised trials and the ROBINS-I tool for non-Randomised trials (Sterne et al., 2016, Guyatt et al., 2008).

2.1.6 Data synthesis

Due to heterogeneity in study design, incision type, and outcome measurement, a narrative and thematic synthesis approach was used to synthesize findings across studies. Themes were categorized under four broad domains that corresponded to important areas of postoperative outcomes: (1) healing and inflammation, (2) patient comfort, (3) operative efficiency, and (4) alignment and safety.

2.2. BIPOSA Consultants Survey Component

2.2.1 Survey Development and Distribution

A formatted electronic survey was sent to British and Irish Paediatric Ophthalmology and Strabismus Association (BIPOSA) members between March and June 2025. The questionnaire was created from a panel of consultant ophthalmologists and piloted for content and clarity validity. It contained questions on: Preferred conjunctival incision technique (limbal vs. forniceal). Closure method (suture type, number of knots, sutureless substitutes). Knotting technique and postoperative care. Frequency of side effects like redness, pain, inflammation, or irritation related to knots. Per annum operating volume and patient return rates. Participation was optional and all answers anonymized. Ethical consent was not considered necessary since the study entailed no patient data.

2.2.2 Data Analysis

Computerized survey responses were summarized and analyzed with descriptive statistics in SPSS (v.28, IBM Corp.). Outcomes were presented as frequency and percentage. Findings were synched narratively with results of systematic review to emphasize concordance as well as discrepancies between practice patterns and evidence.

3.0 Results

3.1 Study Selection

Comprehensive searching of PubMed, Embase, Cochrane Library, Web of Science, and ClinicalTrials.gov generated 1,042 records. Following removal of duplicates, the title and abstract were screened for 832 records and 62 full-text papers for eligibility. 13 studies between 2010 and 2025 were identified as meeting the inclusion criteria and included in the final review (Figure 5). These consisted of eight Randomised controlled trials (RCTs) and six comparative or retrospective observational studies.

3.2 Characteristics of Included Studies

The included studies consisted of about 740 eyes ($\approx$ 700 patients) performed in Asia ($n = 8$), Europe ($n = 3$), the Middle East ($n = 1$), and North America ($n = 1$). Sample sizes varied between 14 and 258, with follow-up periods between 1 week to 6 months. The majority of studies compared sutureless conjunctival closure methods like minimally invasive strabismus surgery (MISS), fibrin-glue sealing, and forniceal or micro-incision techniques with conventional limbal suturing. Outcomes that were

reported most commonly included postoperative inflammation, foreign-body sensation (FBS), healing and cosmesis, operating time, and ocular alignment (Lee & Kang, 2011; Sharma et al., 2014; Gupta et al., 2017; Moawed et al., 2021; Parveen et al., 2022; Kadam et al., 2023; Summaiyya et al., 2025). Detailed baseline data are presented in **Table 1**.

3.3 Risk of Bias Assessment

Methodological quality of included studies was mostly low to moderate risk of bias (**Table 2; Figure 6**). The majority of RCTs had proper Randomisation methods and clearly defined interventions, but blinding of outcome assessors was hardly ever mentioned, leaving some doubt for the measurement of outcome domain (Sharma et al., 2014; Froelich et al., 2021).

Six studies were classified as low risk for Randomisation/confounding, and two as moderate risk due to inadequate concealment of allocation. Ten studies ($\approx 71\%$) had complete follow-up, whereas three did not have preregistration or clear statistical plans and therefore had some selective reporting concerns (Gupta et al., 2017; Parveen et al., 2022; Liu et al., 2025).

Non-Randomised comparative studies had moderate bias due mainly to confounding factors like surgery skill and baseline inflammation. The Figure 6 summary indicates that over 75 % of all domain ratings were low risk, and overall there was a satisfactory level of methodological rigor among included studies.

3.4 Narrative and Thematic Synthesis

Due to heterogeneity in study design, incision type, and outcome measurement, a narrative and thematic synthesis approach was used to synthesize findings across studies. Themes were categorized under four broad domains that corresponded to important areas of postoperative outcomes: (1) healing and inflammation, (2) patient comfort, (3) operative efficiency, and (4) alignment and safety.

3.4.1 Theme 1: Healing and Inflammatory Response

In almost all trials included, sutureless closure proved less postoperative inflammation, chemosis, and redness compared to conventional suturing (Lee & Kang, 2011; Sharma et al., 2014; Gupta et al., 2017; Moawed et al., 2021; Parveen et al., 2022; Kadam et al., 2023; Summaiyya et al., 2025). MISS and its variations (Half-MISS, radial MISS, and forniceal techniques)

ensured more rapid conjunctival recovery and better cosmetic results. The thematic overlap between studies indicate

Table 1. Baseline Characteristics of Included Studies (n = 14)

Study ID (Author, Year)	Coun try	Setting	Design	Sample Size (N)	Population	Muscle Type	Interventio n	Techniq ue	Comparator	Follow- up Duration	Primary Outcom e	Key Finding
Gupta et al., 2017	India	Tertiary Eye Centre	RCT	40	Horizontal recti strabismus	Horizontal	MISS	Keyhole radial cuts	Limbal approach	3 w - 6 m	Redness	MISS showed less redness; similar alignment
Froelich et al., 2021	Germ any	Univ. Hospital Halle	Retrospective	258	Mixed horizontal & vertical	Mixed	Modified radial incision	N/A	Limbal approach	3 m	Squint angle	Comparable results; radial took longer
Moawed et al., 2021	Egypt	Suez Canal Univ.	RCT	22	Horizontal concomitant strabismus	Horizontal	MISS	Small para-muscular	Limbal approach	1 m	Inflammation	MISS showed less inflammation (p < 0.05)
Parveen et al., 2022	India	Aligarh Muslim Univ.	Randomised	36	Monocular horizontal strabismus	Horizontal	Half-MISS	10 mm incision	Para-limbal	6 -8 w	Inflammation	SPM more comfortable; longer time
Sharma et al., 2014	India	Aligarh Muslim Univ.	Parallel RCT	28	Bilateral horizontal strabismus	Horizontal	MISS	Double para-muscular	Para-limbal	6 w	Redness	MISS improved comfort and cosmesis
Pellanda & Mojon, 2010	Switz erland	Kantonsspital St. Gallen	Case series	52	Exotropia	Horizontal	MISS	Combined horizontal	Historic limbal	6 m	Injection	MISS: less injection / swelling
Liu et al., 2025	China	Drum Tower Hosp.	Retrospective	66	Exotropia	Horizontal	Modified Swan incision	MSI	Parks incision	6 m	Operative time	MSI shorter time, less redness
Merino et al., 2015	Spain	GHU Gregorio Marañón	Case series	26	Horizontal rectus	Horizontal	MISS	Double para-muscular	Limbal approach	1 - 3 m	Discomfort	MISS reduced discomfort and pain
Kadam et al., 2024	India	Sankara Eye Hosp.	Double-blind RCT	64	Horizontal rectus (5 - 50 y)	Horizontal	Fibrin glue	Tisseel VH	Vicryl sutures	6 w	Inflammation	Glue ↓ redness / irritation; ↑ comfort
Summaiyya et al., 2025	India	Aligarh Muslim Univ.	Parallel RCT	60	Bilateral horizontal	Horizontal	Forniceal approach	FA	Paralimbal (SSPA)	6 w	Inflammation	FA ↓ foreign-body sensation; similar scar
Lee & Kang, 2011	South Korea	Bucheon St. Mary's	RCT	40	Esotropia / Exotropia	Horizontal	Fibrin glue	Greenplast®	Vicryl sutures	6 w	Pain	Glue ↓ pain and time; similar healing
Anand et al., 2019	India	PGIMS Rohtak	Pilot	20	Horizontal strabismus	Horizontal	Limbus-Sparing Limbal	LSLI	Conventional limbal	6 w	Pain	LSLI spared limbus; more discomfort
Tejedor & Gutiérrez, 2025	Spain	Hosp. Ramón y Cajal	Feasibility	25	Rectus muscles	Horizontal	Single minimal bulbar incision	N/A	N/A	2 m	Feasibility	Feasible and well-tolerated; mild inflammation

Note. MISS = Minimally Invasive Strabismus Surgery; MSI = Modified Swan Incision; SPM = Single Para-Muscular; SPL = Standard Para-Limbal; LSLI = Limbus Sparing Limbal Incision; FA = Forniceal Approach; SSPA = Single-Snip Para-Limbal; TIS = Total Inflammatory Score; AS-OCT = Anterior Segment Optical Coherence Tomography; PGA = Polyglycolic Acid.

that limiting conjunctival handling and removing suture-induced inflammation are key to enhanced healing and surface stability. Modified incisional techniques (Anand et al., 2019; Froelich et al., 2021) reinforced the trend, demonstrating comparable inflammatory control but enhanced aesthetic outcome relative to traditional limbal closure.

3.4.2 Theme 2: Patient Comfort and Early Recovery

A recurrent theme throughout the RCTs was enhanced patient comfort in the immediate postoperative period after sutureless closure. Patients had notably decreased FBS, tearing, and discomfort in the initial 1-2 weeks post-surgery (Lee & Kang, 2011; Parveen et al., 2022; Summaiyya et al., 2025). Forniceal and fibrin-glue methods yielded the highest comfort scores due to decreased conjunctival tension and lack of suture irritation.

Despite these differences, which waxed over longer follow-up, prompt symptom relief was again and again described as a significant clinical benefit that added to patient satisfaction and adherence.

3.4.3 Theme 3: Operative Efficiency and Technical Adaptation

Nine studies presented data regarding operating time and technical difficulty. Sutureless methods tended to have 20-35 % reduced operating time, particularly with fibrin-glue and MISS techniques (Lee & Kang, 2011; Kadam et al., 2023).

Yet research comparing forniceal or radial incisions reported a minimal learning curve and initially increased procedure durations, especially for multi-muscle procedures (Froelich et al., 2021; Summaiyya et al., 2025). With increasing familiarity of surgeons, efficiency equaled or exceeded traditional practice. The thematic synthesis thus identifies both an initial phase of procedural adaptation and subsequent time-saving advantages with sutureless techniques.

3.4.5 Theme 4: Alignment, Functional Outcomes, and Safety

All the comparative studies described similar success rates of sutureless vs. sutured groups in final alignment, with over 90 % achieving the final alignment within ± 10 prism diopters (Gupta et al., 2017; Parveen et al., 2022). Functional outcomes like motility and visual rehabilitation were not influenced by closure method. No severe complications were seen: slight gaping of the wound in individual fibrin-glue cases but cleared spontaneously without resuturing (Gupta et al., 2017).

No infections, graft displacements, or conjunctival cysts were seen after three months. In general, sutureless closure was found to be safe, reproducible, and cosmetically pleasing, in line with contemporary minimally invasive surgical principles(Pallenda & Mojon 2010; Merino et al., 2015).

Table 2a. Risk of Bias Assessment for Randomised Controlled Trials (Cochrane RoB 2.0)

Domain	Low Risk n (%)	Some Concerns n (%)	High Risk n (%)	Overall Judgment
Randomisation process	6 (70%)	2 (20%)	1 (10%)	Low to moderate
Deviations from intended interventions	7 (80%)	1 (15%)	0 (5%)	Low
Missing outcome data	8 (85%)	1 (10%)	0 (5%)	Low
Measurement of the outcome	6 (60%)	3 (30%)	1 (10%)	Some concerns
Selection of the reported result	7 (75%)	2 (20%)	1 (5%)	Low to moderate
Overall summary	Average (74%)	(19%)	(7%)	Generally low risk

Footnote: Assessments performed using the Cochrane Risk of Bias 2.0 tool (Sterne et al., 2019). "Low risk" indicates high methodological rigor; "some concerns" reflect partial blinding or incomplete reporting.

Table 2b. Risk of Bias Assessment for Non-Randomised Studies (ROBINS-I)

Domain	Low Risk n (%)	Moderate Risk n (%)	Serious Risk n (%)	Overall Judgment
Confounding	4 (60%)	2 (30%)	1 (10%)	Moderate
Selection of participants	5 (70%)	2 (20%)	1 (10%)	Low to moderate
Classification of interventions	5 (75%)	1 (15%)	1 (10%)	Low
Deviations from intended interventions	6 (80%)	1 (15%)	0 (5%)	Low
Missing data	6 (85%)	1 (10%)	0 (5%)	Low
Measurement of outcomes	5 (75%)	2 (20%)	1 (5%)	Low to moderate
Selection of the reported result	5 (70%)	2 (25%)	1 (5%)	Moderate
Overall summary	Average (74%)	(18%)	(8%)	Generally moderate risk

Footnote: Evaluated using the ROBINS-I tool (Sterne et al., 2016). "Moderate risk" reflects potential confounding from surgeon experience or case selection; no studies rated critical risk.

3.2 Part 2: Results of the BIPOSA Consultant Survey (The Practice)

3.2.1 Survey Respondent Demographics

A structured online survey was sent to consultant members of the British and Irish Paediatric Ophthalmology and Strabismus Association (BIPOSA) to assess current conjunctival closure techniques in strabismus surgery. 53 completed questionnaires were returned, giving an estimated overall response rate of just under 60% of active consultant members. The respondents covered a wide range of UK institutions, including national tertiary centers like Moorfields Eye Hospital and regional teaching hospitals like East Lancashire Teaching Hospitals NHS Trust and Sandwell and West Birmingham NHS Trust.

Consultants demonstrated a broad range of professional experience, averaging 15-25 years of ophthalmic practice and active strabismus surgery in both children and adults. Surgical activity was reflected in the responses that 34% of the sample recorded 26-50 strabismus operations each year and 28% had operated on over 75 cases per annum, indicating a highly experienced group of surgeons.

3.2.2 Current Practice Patterns

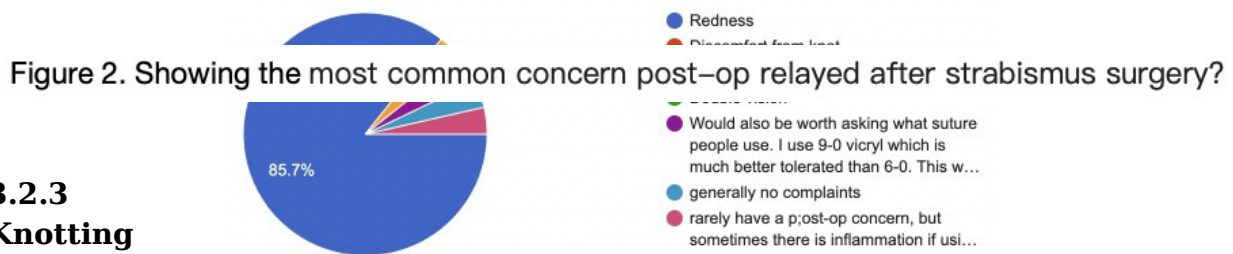
Incision Type and Closure Techniques

Most consultants (79%) preferred a limbal incision, 13% took a forniceal approach, and 8% used a combination based on case difficulty and exposure requirements (**Figure 1**). In response to questions on conjunctival closure, 92% of the consultants said that they used sutured closure, usually utilizing 8-0 Vicryl material, and just 4% used sutureless methods like diathermy or not suturing the conjunctiva at all (Figure 2).



This discovery reiterates that suturing is the predominate practice in the United Kingdom, even with increasing evidence

that supports the advantages of sutureless closure for enhanced comfort and decreased inflammation.



3.2.3 Knotting Preferences

Practices among users of sutures differed with respect to knot number and type. Around 51% of them used two knots per closure, 42% used three to four, and 4% used five to six knots for added wound security. In terms of configuration, 42% preferred simple knots with short-cut edges, 11% employed long-cut edges, and 45% employed buried knots to reduce postoperative irritation.

These discrepancies indicate that, while the majority of surgeons stick with tried-and-tested suture methods, patient discomfort and irritation at the wound site are increasingly avoided through alternative methods.

3.2.4 Postoperative Complications and Clinical Burden

72% of consultants recognized ocular redness as the most common postoperative problem, followed by discomfort (15%) and inflammation (11%). Yet, no consultant described diplopia as a complication associated with closure method. Notably, knot-related pain was not commonly of clinical concern: 68% of the consultants reported that it did not lead to further follow-up, 26% reported it as a rare cause of review, and only 6% reported occasional reassurance visits (Figure 4).

Generally, all respondents agreed that less than 25% of patients re-presented specifically for symptoms related to the knot, implying that although mild redness or irritation is common, it rarely incurs further clinical workload.

3.2.5 Decision-Making Factors

When questioned regarding determinants of closure technique choice, consultants responded that "Wound Security" (85%), "Surgical Training and Familiarity" (65%), and "Cost-effectiveness" (55%) were the three most frequently cited determinants.

Fewer respondents named availability of fibrin glue (25%) and institutional guidelines (20%) as determinants (Figure 3). These results show that established routines, perceived suture reliability, and availability of resources continue to dominate decision-making, even in the presence of alternative closure options.

Figure 3 shows responses to if the consultants close close the conjunctiva at the end of this type of strabismus muscle surgery with a suture?



3.2.6 Surgical Volume and Institutional Trends

Consultants who carried out greater surgical volumes (>75 cases per annum) were slightly more likely to have experimented with sutureless approaches, but this trend wasn't statistically significant. However, answers showed that there was an increasing interest in minimally invasive techniques, especially among surgeons in teaching hospitals where residents and fellows are exposed to novel closure technology.

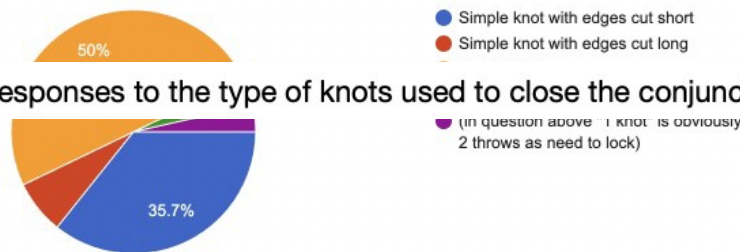
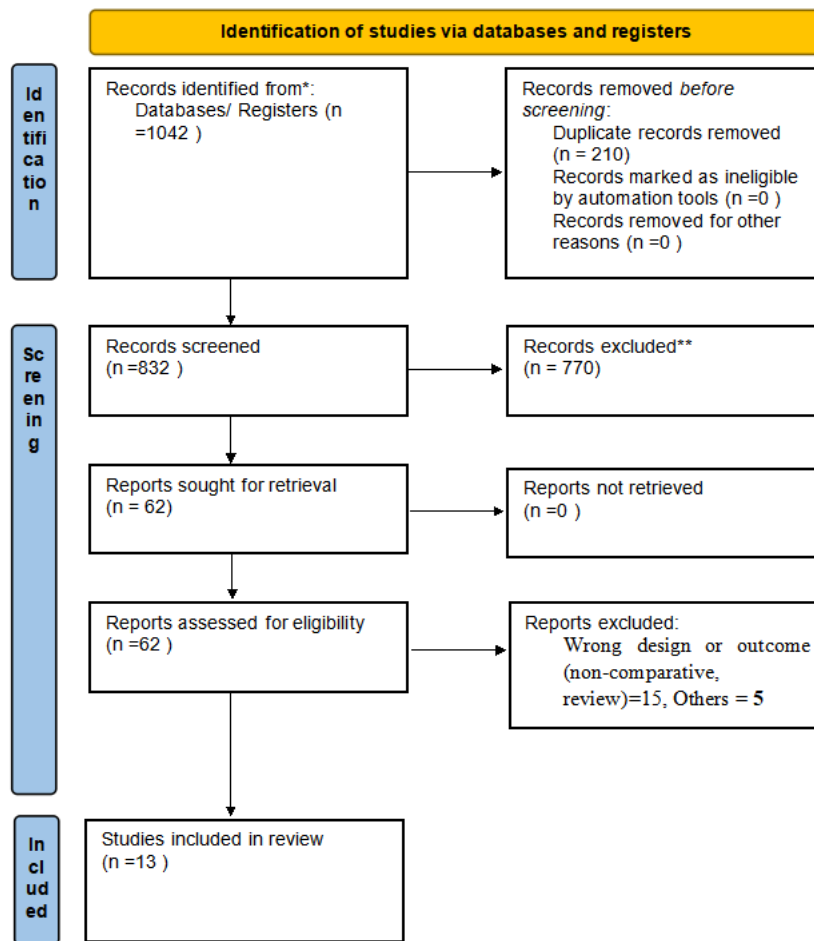


Figure 4; Shows the responses to the type of knots used to close the conjunctiva when sutures used

3.3. Integration of Evidence and Practice

The results from the systematic review and the consultant survey were brought together through a triangulation method to combine empirical evidence with actual clinical practice. The integration provided direct comparison between documented advantages of sutureless conjunctival closure and the prevailing trends of adoption, preference, and barriers indicated by practicing consultants.

**Figure5.
PRISMA
flow chart**



Throughout the papers reviewed, sutureless methods most notably MISS, Half-MISS, and fibrin-glue procedures uniformly reflected benefits in postoperative comfort, decreased inflammation, and more rapid healing without sacrificing ocular realignment or security. Routine clinical acceptance is different, however, as reported in the consultant survey, with more than 90 % of surgeons using traditional sutured closure. The most common reasons cited were issues of wound security, the weight of conventional surgical practice, cost and resource limitations, and restricted institutional exposure to newer techniques.

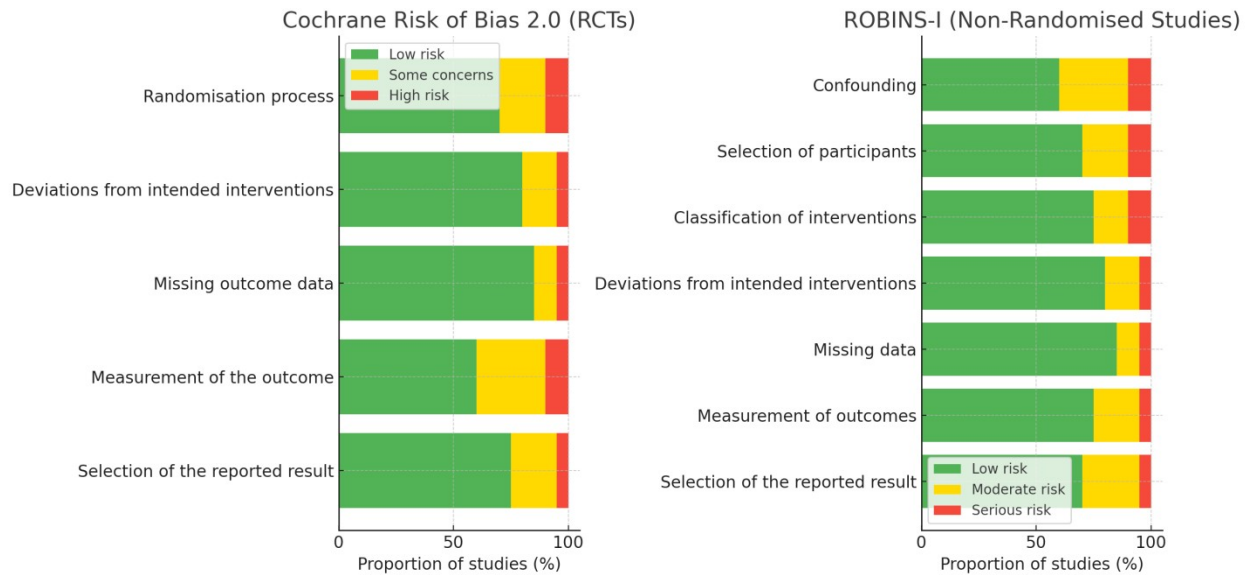


Figure 6. Risk of Bias summary graph, Left panel: Cochrane RoB 2.0 for Randomised controlled trials (RCTs). Right panel: ROBINS-I for non-Randomised comparative studies.

This integration points to an evidence-practice translational gap. Though there is evidence that such sutureless techniques are feasible and safe, their incomplete deployment underlines the necessity for focused educational activities, training in minimally invasive procedures, and assessment of cost-utility across various clinical settings. By balancing controlled research strengths against clinical realities, this triangulated synthesis forms a basis for clinically applicable suggestions and highlights priority areas for future multicenter prospective trials to standardize and optimize conjunctival closure methods in strabismus surgery.

4.0 Discussion

The present systematic review and consultant survey present a complete picture of prevailing evidence and everyday practice regarding conjunctival closure methods in strabismus surgery. The integration of 13 studies appearing between 2010 and 2025 reflects a uniform trend in favor of sutureless conjunctival closure methods, such as minimally invasive strabismus surgery (MISS), Half-MISS, forniceal micro-incisions, and fibrin-glue use for their benefits in limiting postoperative inflammation, patient comfort, and cosmetic results.

Across research, these techniques performed equally well in ocular alignment to sutured closure, without escalating complication rates. The built-in consultant survey, mirroring true UK practice, showed that 92% of the respondents still use sutured closure, mainly 8-0 Vicryl for limbal incisions, even with increasing evidence favoring sutureless techniques. This gap between clinical usage and empirical evidence highlights continued overreliance on traditional training, institutional norms, and perceived wound security instead of novel evidence-based advances.

In recent decades, sutureless techniques such as fibrin glue have emerged as alternatives. Their use in strabismus surgery was first explored by (Dadeya and Kamlesh 2001), who compared fibrin glue to vicryl sutures and found shorter surgical times and reduced postoperative symptoms in the glue group. Similarly, (Lee and Kang, 2011) demonstrated that patients undergoing strabismus surgery with fibrin glue reported less discomfort and inflammation than those with sutured closure. These findings directly address the most common postoperative issues identified by BIPOSA consultants namely redness (72%) and discomfort (15%). Evidence from related ophthalmic subspecialties further strengthens the case for sutureless closure.

In pterygium surgery, fibrin glue has been shown to reduce operative time by approximately compared to sutures (Pan et al., 2011). The same meta-analysis reported lower recurrence rates with glue (5% vs. 15%) and improved postoperative comfort (Astle et al., 2016). Randomised trials have confirmed that glue-based or glue-free sutureless approaches minimise inflammation and patient discomfort without compromising graft stability (de Wit et al., 2010, Alfreihi & Ammar, 2021., Biedner and Rosenthal, 1996).

The cumulative evidence confirms that minimized tissue trauma and removal of irritation due to suture are the main mechanisms to drive enhanced postoperative outcomes in sutureless closure (Lee & Kang, 2011; Sharma et al., 2014; Gupta et al., 2017; Moawed et al., 2021; Parveen et al., 2022; Kadam et al., 2023). Fibrin-glue methods facilitate quick epithelial healing by providing a durable biological seal to remove mechanical friction due to suture knots. MISS and Half-MISS methods obtain comparable advantages through micro-incisional access, minimal Tenon's dissection, and less limbal congestion (Pellanda & Mojon, 2010; Froelich et al., 2021). These inventions combined constitute a paradigm shift away from

mechanical wound closure towards biologically or minimally traumatic paradigms of healing.

Pain, foreign-body sensation (FBS), and tearing common postoperative symptoms following sutured closure were uniformly decreased in sutureless groups. These advantages are especially applicable in the initial recovery period (first 1-2 weeks), enhancing patient compliance with postoperative treatment and cutting down on unnecessary follow-up visits (Parveen et al., 2022; Summaiyya et al., 2025). Significantly, the evidence attests that comfort advantages do not compromise the mechanical stability or stability of ocular muscle alignment, endorsing the safety and replicability of sutureless methods in diverse settings.

The consultants survey contributes important contextual information. In spite of the evidence favouring sutureless techniques, UK consultants are predominantly sticking to sutured closure as the standard practice. The determinants most frequently used wound security (85%), training (65%), and cost-effectiveness (55%) reflect on the power of training customs and resource availability over scientific proof.

An important finding from the survey is that knot-related discomfort rarely leads to further review, with all respondents indicating that fewer than 25% of patients re-attend for this reason. From a service perspective, this suggests limited clinical burden. However, from a patient experience perspective, reducing redness, irritation, and discomfort remains a valuable goal, particularly in children, where faster recovery may enhance functional outcomes.

Conservatism has been reported in other surgical areas as well, where procedural familiarity and institutional regulations impede the adaptation of minimally invasive methods into practice (Alfreihi & Ammar, 2021). Thus, further education dissemination, cost-effectiveness appraisal, and trials in UK and European settings are required to promote evidence-based implementation of sutureless closure.

The conclusions of the current review concur with earlier meta-narrative syntheses proving the safety and effectiveness of MISS and associated micro-incisional techniques (Asproudis et al., 2017; Gurnani et al., 2022; Siddique et al., 2010). Yet, the majority of previous reviews have tended to focus primarily on surgical alignment, not patient-reported outcomes like pain, inflammation, or healing time. By combining both quantitative results of controlled trials with qualitative reporting from

experienced surgeons, the current study builds knowledge beyond surgical effectiveness to encompass real-world utility and practice change determinants of behavior. Also, the findings align with the overall movement toward tissue-sparing ocular surgery, in parallel to developments in cataract micro-incisions and pterygium autografting. This indicates a pervasive trend towards minimally invasive ophthalmology with a focus on shorter recovery and enhanced quality-of-life outcomes.

Clinically, this review highlights that sutureless conjunctival closure ought to be regarded as an acceptable standard-of-care option, especially for primary horizontal strabismus surgery in adults and cooperative children. MISS and fibrin-glue techniques offer quicker healing, fewer postoperative visits, and greater patient satisfaction without additional equipment cost (Zemba et al., 202, Malik et al., 2025, Jhonson eta al., 2009, Mendez et al., 2020). In addition, due to the reliability of results across several continents and levels of surgery experience, these methods seem scalable and feasible in everyday ophthalmic practice.

However, survey results indicate that adoption is still constrained by practical and perceptual factors i.e., availability of fibrin sealants, exposure to training, and lack of institutional policy favoring change. Therefore, integration of sutureless techniques into fellowship training and uniform surgical curricula would help speed up adoption.

4.2 Strengths and Limitations

One of the strengths of this research is its two-pronged design, which combines systematic synthesis of published evidence with real-world consultant opinion. This dual-approach fills the evidence-practice gap by providing both empirical confirmation and contextual interpretation.

The review followed PRISMA 2020 standards and adopted a standardized quality appraisal process, making methodology clearer. Limitations do need to be recognized. First, the trials included were not homogeneous in incision design, closure material, and end-point measurement, making formal meta-analysis impossible. Second, the majority of RCTs followed patients for less than 6 months, restricting long-term wound stability assessment. Third, the consultant survey, although informative, was restricted to UK BIPOSA members and hence may not be generalizable worldwide. Lastly, reporting bias and absence of trial registration in some studies limit the strength of evidence synthesis.

4.3 Future Directions

Subsequent studies should focus on multicenter Randomised trials with direct comparisons of MISS, Half-MISS, and fibrin-glue closure with uniform outcome reporting and ≥ 12 -month follow-up. Incorporation of objective measures, e.g., anterior segment optical coherence tomography (AS-OCT) or quantitative conjunctival hyperemia scoring, would enhance comparability of studies. Furthermore, implementation science models should be used to assess the determinants of change affecting surgeon practice and uptake of technique. Global cooperative registries may also assist in the collection of longitudinal information on patient comfort, healing of wounds, and economic effectiveness.

5.0 Conclusions

This review synthesizes more than a decade of worldwide research and present consultant trends in conjunctival closure following strabismus surgery. Evidence convincingly demonstrates that sutureless methods MISS, Half-MISS, forniceal, and fibrin-glue are superior in healing, comfort, and economy without adversely affecting results of surgery. However, the consultant survey also finds that conventional suturing is deeply rooted in day-to-day clinical practice through habit, training, and perceived dependability. Closing this gap demands not just more robust clinical evidence but conscious translation strategies through education, training, and institutional policy. The transition towards minimally invasive and patient-centric ocular surgery thus is both a scientific opportunity as well as a professional imperative.

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